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(56) Documents cited
GB 1514171 A EP 0234052 A US 4345569 A
US 4212275 A US 4103658 A

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(54) I.C. engine fuel vaporiser having a porous electric heating element

(57) A porous body 22 of carbon or ceramic material, made by a process involving carburizing fibres of an organic polymer, forms the heating element of a fuel vaporizer. Fuel is injected from an injector 12 directly into a space 20 in the body 22. There may be a secondary flow of air flowing through a passage 30 to carry the vaporized fuel into an intake manifold 10 through an opening 32. Alternatively the main flow of air through the intake manifold may pass through the porous body (22', Fig. 2).

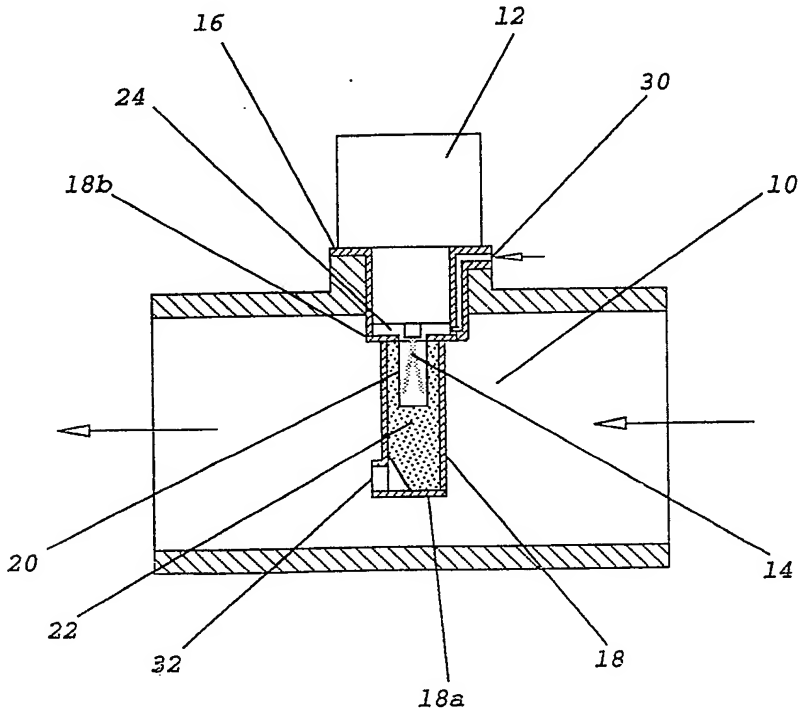

Fig.1

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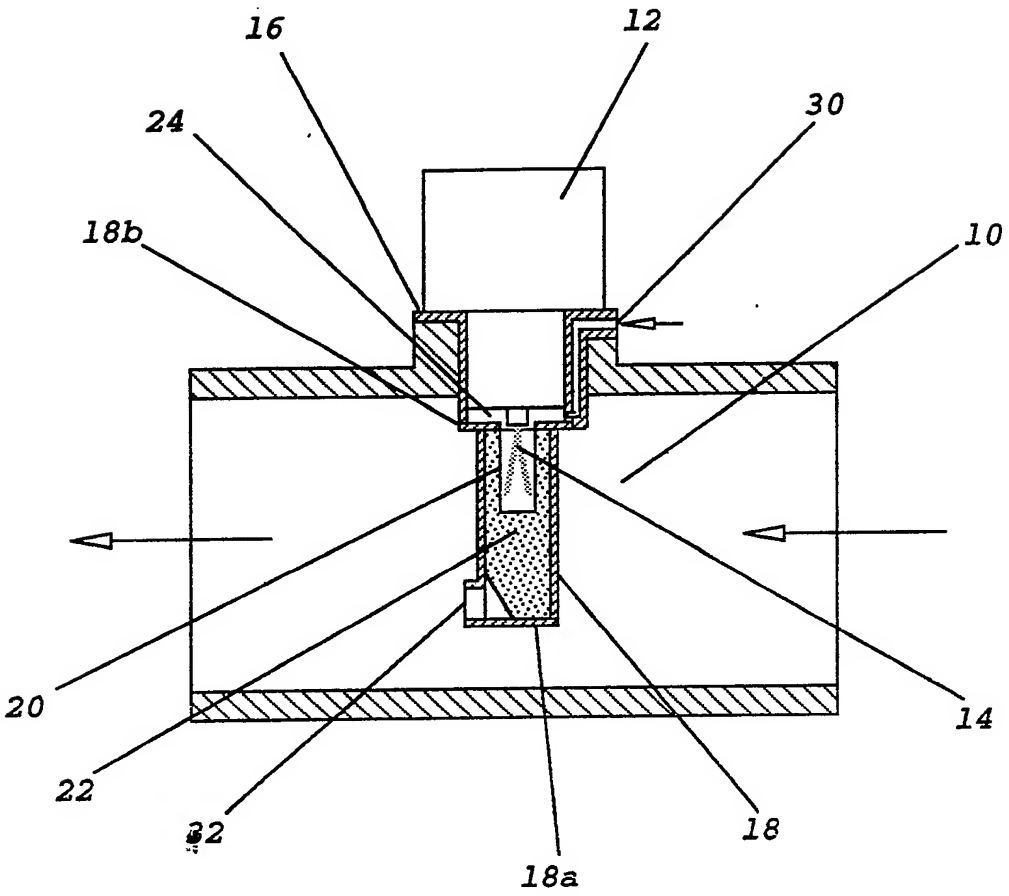

Fig.1

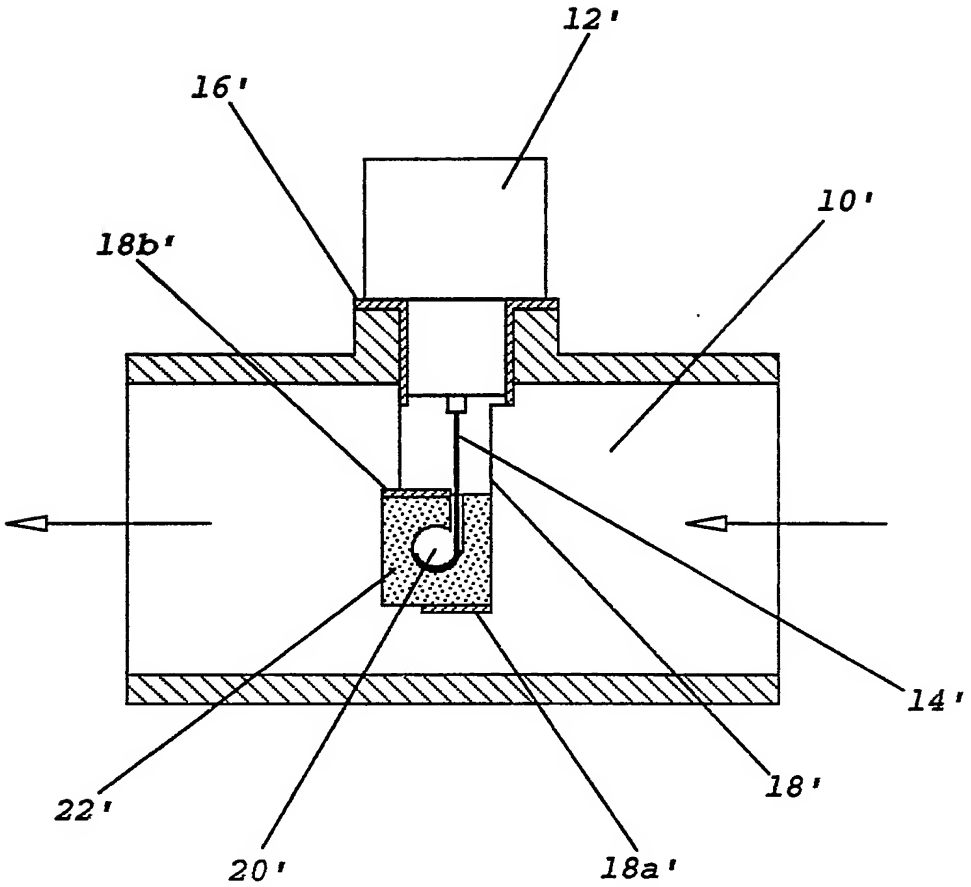

Fig.2

Title

Fuel Vaporiser

Field of the invention

The present invention relates to a fuel vaporiser for use in a fuel injection system of an internal combustion engine.

Background of the invention

It is desirable to vaporise the fuel emitted from an injector before it enters the combustion chamber in order to reduce wetting of the intake port and to improve the burning of the fuel within the combustion chamber. To this end, various systems have already been proposed in the past which involve heating the charge in order to vaporise the fuel.

In US-4,103,658 a carburettor is described having a chamber filled with a porous material which is heated by means of a heating element. The metered fuel is fed into this chamber and the air from the intake throttle is drawn through the same chamber. In US-4,510,13 and US-4,476,840 a chamber is filled with a wire wool material instead of a porous material and acts in essentially the same manner to vaporise the fuel using an external heat source.

There are inherent problems in such a design because the large surface area required for vaporising the fuel acts as an area over which liquid fuel may accumulate. Consequently, during non-steady state operation, that is during acceleration and deceleration, the hysteresis effect of the presence of the vaporiser is the same as or even worse than that of a wet manifold. In particular, during fast transients, though the fuel metering may change rapidly, the air to fuel ratio received in the engine cylinders responds much more slowly.

The efficiency of the vaporiser is impaired by the fact that the overall cross section of the heat exchanger is large and much if not all of the intake air is required to flow through it. This results in the heat in the wire wool or the porous material being used to heat the intake air as well as to vaporise the fuel.

Lastly, the external heating of the wire wool or porous material is not effective because the material which provides a large surface area for improving the heat transfer to the liquid fuel is itself an inefficient heat conductor for the heat from the external source.

Because of all the disadvantages outlined above, despite the presence of several disclosures in the prior art relating to vaporisation of fuel in the intake manifold of an internal combustion engine, none is believed ever to have been used commercially in an automotive application.

Object of the invention

The invention seeks to provide a fuel vaporiser which allows rapid changes to be made to the amount of fuel in the charge admitted into the combustion chambers yet allows effective vaporisation of the fuel content.

Summary of the invention

According to the present invention, there is provided a fuel vaporiser to be mounted in close proximity to an injector in an intake manifold of a fuel injected internal combustion engine for passage through the vaporiser of the jet of fuel emitted from the injector, the vaporiser comprising an electric heating element formed of a porous body of carbon or ceramic material made by a process involving carbonising fibres of an organic polymer.

Heating elements made of porous carbon formed by carbonising acrylic fibres have been known for more than ten years and were developed in Harwell by the UK Atomic Energy Authority. The heaters start as acrylic fibre which is processed into a dense blanket. The blanket is carbonised to form a strong electrically conducting fibrous element. A ceramic version can be made by coating such an element with silicon carbide and burning the carbon fibres away.

Such heating elements have been used to produce small and powerful fluid heaters which have found application principally in the degassing of transformer oils. It has also been suggested that they may find automotive application in heating catalytic converters.

The present invention is predicated on the realisation that their very high power output per unit mass (reported to be as high as 1 KW / gm) coupled with their very large internal surface area per unit mass (as much as 500 m^2 / gm) makes these heating elements ideal for use as a fast response fuel vaporiser.

A physically small unit, which cannot act as a large fuel reservoir, can be heated efficiently by passing a current through the porous carbon or ceramic of which it is formed and its entire heat output can be used to vaporise the fuel without it being cooled to any significant extent by the air in the intake charge.

The unit is preferably designed to ensure that the fuel from the injector must pass through the heating element. This may be effected either by mounting the heating element directly on the injector or by mounting it in close proximity to the injector. In the latter case, it is convenient to form the heating element with an internal cavity having a single access duct down which the fuel is directed as a fine pencil jet by the injector.

If the heating element is to be mounted directly on the injector, then it is desirable to take steps to ensure that the heat from the heating element is prevented from causing overheating of the fuel within the injector.

On vaporisation, the pressure within the heating element will rise considerably and the vaporised fuel will naturally be forced out of the element. However, this process can be assisted by a small flow of purging gas which may be ambient air, compressed intake air or even exhaust gases.

Brief description of the drawings

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram showing a first embodiment of the invention, and

Figure 2 is a similar representation of alternative embodiment of the invention.

Detailed description of the preferred embodiment

In Figure 1, there is illustrated a fuel injector 12 mounted in an intake manifold 10. The injector 12 may be common to several or all the cylinders or it may be an individual injector associated with a single intake port. The injector is fitted into a cup 16 which is itself secured in an opening in the intake manifold. The cup 16 acts as a holder for a porous carbon heating element 22 which is held in a position to intercept the fuel spray 14 from the injector 12 but which is spaced from the injector 12 by a small gap 24 to prevent the injector from being overheated.

The base of the cup 16 acts as a first, annular, electrode 18b arranged at one end of the heating element 22. The element 22 is contained within an electrically insulating sleeve 18 secured to the cup 16 and at the opposite end of the element 22 there is a second electrode 18a which completes the enclosure for the element.

An aperture 32 is formed in the sleeve 18 at its lower end as viewed to allow vaporised fuel to enter the intake manifold and a cavity 20 is formed in the heating element 22 to collect all the fuel in the spray from the injector 12.

The cup 16 is further provided with a duct 30 for purge air which allows a small quantity of air to pass through the gap 24 and the heating element 22 into the intake manifold. This air carries all the fuel vapours into the intake manifold to ensure that all the metered fuel reaches the engine cylinder(s). The air entering the duct 30 may either be drawn in by the manifold vacuum or it may be supplied under pressure. The air forms part of the metered air supply and does not therefore reduce the mixture strength. Furthermore, the total amount of air that needs to be drawn in through the duct 30 for purging purposes is smaller than the air flow rate during idling and even in the case where the air is drawn in by manifold vacuum from air under at ambient pressure, it does not interfere with the engine tick over.

In the case where the air is supplied by a compressor, if the intake of the compressor is downstream from the intake throttle, then the total air charge is not at all affected by the rate of flow of the purge air. However, in this case, the compressor forms a recirculation loop and if fuel is allowed to pass around the entire loop then the compressor will form part of the manifold system and will upset the fuel metering by acting as a fuel reservoir. On other hand, if the connections of the compressor to the

manifold are sufficiently far apart, there will not be sufficient time for the fuel vapours to re-enter the compressor before they are sucked into the engine cylinders. The compressor will then not receive fuel vapours and will not disturb the fuel metering.

The element 22 is formed of porous carbon or ceramic which is made in the manner described earlier. The element, despite its small physical size, which allows it to be integrated with the injector has a high internal surface area for heating the fuel and can also dissipate significant quantity of electrical energy. Current is applied to the heating element 22 through the electrodes 18a and 18b and the heat emitted vaporises rapidly the fuel spray which collects in the cavity 20. The increased vapour pressure in the cavity 20 drives the fuel through the porous element into the manifold. During its passage through the porous element 22, the fuel is heated further to ensure its complete vaporisation. The passage of the fuel through the heating element 22 is assisted by the purge air, if such is present, which ensures that little fuel remains trapped in the element.

The vaporiser in this way provides a well prepared charge and minimises the effect of wall wetting. Because of its small size and the fact that it stores so little fuel, the vaporiser permits accurate fuel metering, virtually on a cycle by cycle basis, enabling the engine to be controlled accurately even during transients, that is to say rapid acceleration and deceleration.

Because the vaporiser reduces the hysteresis effect caused by wetting the intake port, not only does the precise amount of fuel metered by the injector in a cycle reach the cylinder in that cycle but the time that the fuel reaches the cylinder is also determined by the time that the fuel is discharged by the injector. Therefore, by proper timing of

the injector, it is possible to vary the degree of charge stratification within the combustion chamber. This may be desirable for example in a lean burn engine as the fuel injection may be delayed to achieve a readily ignitable mixture in the vicinity of the spark plug despite the fact that the average mixture strength may be lean.

Figure 2 differs in only a few respects from the embodiment of Figure 1. Primed reference numerals have been used to designate corresponding parts in order to avoid the need to repeat the description.

The major differences are that there is no external source of purge air and the flow of the intake air past the element 22' is relied upon to effect the purging. The element 22' is well spaced from the injector 12' to avoid the heat of the element 22' reaching the injector 12'. In view of the spacing, a pencil jet 14' is required to aim the fuel into the cavity 20' of the heating element 22'.

The invention can be seen to improve fuel injection systems by providing better fuel preparation and reducing wetting of the intake port. These improvements are advantageous during cold start, warm up and transient conditions. The accurate fuel metering at all times allows emissions in particular to be kept under tight control not only during steady state warm operation but under all driving conditions.

Claims

1. A fuel vaporiser to be mounted in close proximity to an injector in an intake manifold of a fuel injected internal combustion engine for passage through the vaporiser of the jet of fuel emitted from the injector, the vaporiser comprising an electric heating element formed of a porous body of carbon or ceramic material made by a process involving carbonising fibres of an organic polymer.

2. A fuel vaporiser as claimed in claim 1, wherein, in order to ensure that the fuel from the injector passes through the heating element, the heating element is mounted in close proximity to but spaced from the injector.

3. A fuel vaporiser as claimed in claim 2, wherein the heating element is formed with an internal cavity having an access duct down which the fuel is directed as a fine jet by the injector.

4. A fuel vaporiser as claimed in claim 1, wherein, in order to ensure that the fuel from the injector passes through the heating element, the heating element is mounted directly on the injector.

5. A fuel vaporiser as claimed in claim 4, wherein a gap is provided between the injector and the heating element to prevent the heat from the heating element from directly heating the injector.

6. A fuel vaporiser as claimed in claim 4 or 5, wherein means are provided for directing a flow of purge air through the heating element, to assist in driving fuel vapours from the heating element into the intake manifold.

7. A fuel vaporiser constructed, arranged and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

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Relevant Technical fields

(i) UK Cl (Edition K) F1B, H5H (HCB)

(ii) Int Cl (Edition 5) F02M 29/04, 31/02, 31/125, 31/18, 33/02

Search Examiner
S WALLER

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search
23.3.92

Documents considered relevant following a search in respect of claims 1-7

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	GB 1514171 (UK AEA) see page 1 lines 9 to 15	1
Y	EP 0234052 (TEXAS INSTRUMENTS HOLLAND) see Column 2, lines 40 to 54	1
Y	US 4345569 (NIPPON SOKEN INC) Column 3, lines 3 to 31	1
Y	US 4212275 (NISSAN MOTOR CO LTD)	1
A	US 4103658 (CONLIN)	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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